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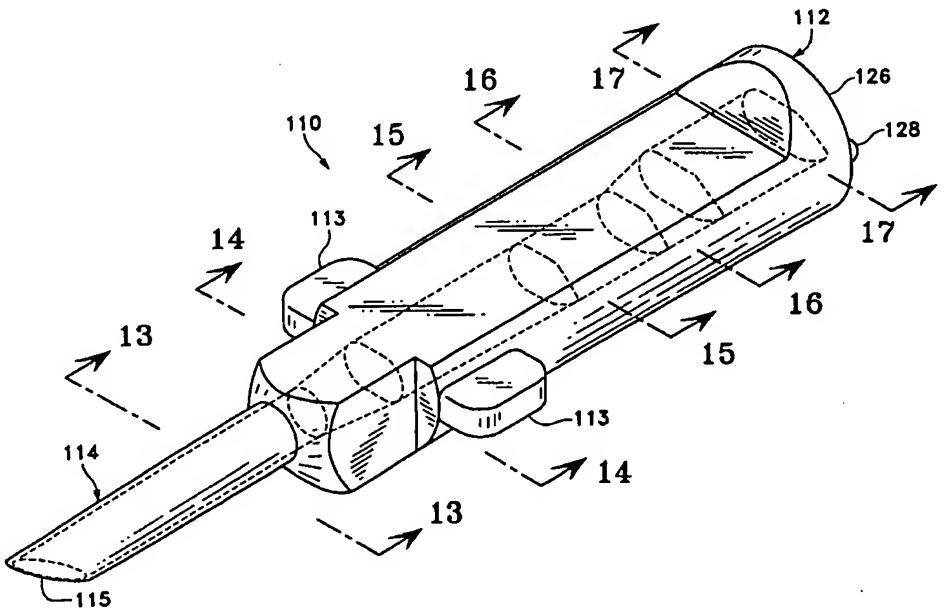
(54) Title: ASYMMETRIC INTRAOCULAR LENS INJECTION CARTRIDGE



(57) Abstract

A lens injector cartridge having an asymmetric bore. The asymmetric bore initiates the folding of the lens on one side only, thereby reducing the amount of energy imparted to the lens and the potential for damage to the lens. The gentle folding of the lens also assists in positioning the travel of the haptics down the bore, thereby reducing the potential for damage to the haptics.

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ASYMMETRIC INTRAOCULAR LENS INJECTION CARTRIDGE

This invention relates to intraocular lenses (IOLs) and more particularly to cartridges used to inject IOLs into an eye.

Background of the Invention

The human eye in its simplest terms functions to provide vision by transmitting and refracting light through a clear outer portion called the cornea, and further focusing the image by way of lens onto the retina at the back of the eye. The quality of the focused image depends on many factors including the size, shape and length of the eye, and the shape and transparency of the cornea and lens.

When trauma, age or disease cause the lens to become less transparent, vision deteriorates because of the diminished light which can be transmitted to the retina. This deficiency in the lens of the eye is medically known as a cataract. The treatment for this condition is surgical removal of the lens and implantation of an artificial lens or IOL.

While early IOLs were made from hard plastic, such as plymethylmtharcrylate (PMMA), soft foldable IOLs made from silicone, soft acrylics and hydrogels have become increasingly popular because of the ability to fold or roll these soft lenses and insert them through a smaller incision. Several methods of rolling or folding the lenses are used. One popular method is an injector cartridge that folds the lenses and provides a relatively small diameter lumen through which the lens may be pushed into the eye, usually by a soft tip plunger. The most commonly used injector cartridge design is illustrated in U.S. Patent No. 4,681,102 (Bartell), the entire contents of which is incorporated herein by reference, and includes a split, longitudinally hinged cartridge. Similar designs are illustrated in U.S. Patent Nos. 5,494,484 and 5, 499, 987 (Feingold) and 5,616,148 and 5,620,450 (Egales, et al.), the entire contents of which are incorporated herein by reference. In an attempt to avoid the claims of U.S. patent No. 4,681,102, several solid cartridges have been investigated, see for example U.S. Patent No. 5,275,604 (Rheinish, et al.) and 5,653,715 (Reich, et al.), the entire contents of which are incorporated herein by reference.

These prior art cartridges all have a smooth, round or elliptical bore that is symmetric about the longitudinal axis. While a smooth round bore works well with elastic materials such as silicones and hydrogel, viscoelastic materials such as soft acrylics do not roll or fold as easily, and preferably are rolled or folded more gradually to help prevent damage to the optic and/or haptic.

Accordingly, a need continues to exist for an IOL injector cartridge that gently folds the IOL.

Brief Summary of the Invention

The present invention improves upon prior art injector cartridges by providing a cartridge having an asymmetric bore. The asymmetric bore initiates the folding of the lens on one side only, thereby reducing the amount of energy imparted to the lens and the potential for damage to the lens. The gentle folding of the lens also assists in positioning the travel of the haptics down the bore, thereby reducing the potential for damage to the haptics.

It is accordingly an object of the present invention to provide a lens injector cartridge having an asymmetric bore.

It is a further object of the present invention to provide a lens injector cartridge that generally folds the lens.

It is a further object of the present invention to provide a lens injector cartridge that minimizes the potential for damage to the optics and/or the haptics.

Other objects, features and advantages of the present invention will become apparent with reference to the drawings, and the following description of the drawings and claims.

Brief Description of the Drawings

FIG. 1 is a side elevational view of the first embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 2 a front elevational view of a first embodiment of the intraocular lens injection cartrige of the present invention.

FIG. 3 is a rear elevational view of a first embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 4 is a top plan view of a first embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 5 is a longitudinal cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention taken along line 5-5 in FIG. 1.

FIG. 6 is a longitudinal cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention similar to FIG. 5 illustrating an intraocular lens partially folded.

FIG. 7 is a transverse cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention taken along line 7-7 in FIG. 6.

FIG. 8 is a longitudinal cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention similar to FIGS. 5 and 6 illustrating the initial folding of one side of an intraocular lens.

FIG. 9 is a transverse cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention similar to FIG. 7 but taken along line 9-9 in FIG. 8.

FIG. 10 is a longitudinal cross-sectional view of a first embodiment of the intraocular lens injection cartridge of the present invention similar to FIGS. 5, 6 and 8 illustrating the initial position of an intraocular lens in the bore.

FIG. 11 is a rear elevational view of a first embodiment of the intraocular lens injection cartridge of the present invention similar to FIG. 3 but illustrating the initial position of an intraocular lens in the bore.

FIG. 12 is a perspective view of a second embodiment of the intraocular lens injection cartridge of the present invention showing the bore in shadow line.

FIG. 13 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 13-13 in FIG. 12.

FIG. 14 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 14-14 in FIG. 12.

FIG. 15 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 15-15 in FIG. 12.

FIG. 17 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 17-17 in FIG. 12.

FIG. 18 is a top plan view of a third embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 19 is a rear elevational view of the third embodiment of the intraocular lens injection cartridge of the present invention illustrated in FIG. 18.

FIG. 20 is a side elevational view of the third embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 21 is a top longitudinal cross-sectional view of the fourth embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 22 is a side longitudinal cross-sectional view of the fourth embodiment of the intraocular lens injection cartridge of the present invention.

FIG. 23 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 23-23 in FIG. 21.

FIG. 24 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 24-24 in FIG. 21.

FIG. 25 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 25-25 in FIG. 21.

FIG. 26 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 26-26 in FIG. 21.

FIG. 27 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 27-27 in FIG. 21.

FIG. 28 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 28-28 in FIG. 21.

FIG. 29 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 29-29 in FIG. 21.

FIG. 30 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 30-30 in FIG. 21.

FIG. 31 is a transverse cross-sectional view of the bore that may be used with the present invention taken along line 31-31 in FIG. 21.

Detailed Description of the Invention

As best seen in FIGS. 1, 4, 12, 18, 20 and 21, intraocular lens injector cartridge 10, 110, 210 and 310 of the present invention generally has tubular body 12, 112, 212 and 312 and injection nozzle 14, 114, 214 and 314. Cartridge 10, 110, 210 and 310 preferably is modeled as a single piece from any suitable thermoplastic, such as polyproplyene, and the thermoplastic may contain a lubricity enhancing agent such as those disclosed in the U.S. Patent No. 5,716,364, the entire contents of which is incorporated herein by reference. Alternatively, cartridge 10, 110, 210 and 310 may be made from stainless steel or titanium. Nozzle 14, 114, 214 and 314 preferably is rounded, oval or elliptical in cross-section and has a cross-sectional area of between 1.5 mm^2 to around 6.5 mm^2. Distal tip 15, 115, 215 and 315

of nozzle 14, 114, 214 and 314 preferably is rounded on the interior and exterior.

As best seen in FIGS. 4, 12, 18, 19 and 21, body 12, 112, 212 and 312 preferably contain grips 13, 113, 213 and 313 that allow easier manipulation of cartridge 10, 110, 210 and 310 and provide a mechanism to lock cartridge 10, 110, 210 and 310 in the injection handpiece (not shown). As best seen in FIG. 4, body 12 may contain opening 16, that communicates with bore 18. Opening 16 allows visualization of IOL 20 and haptics 22 as IOL 20 enters nozzle 14. Alternatively, as shown in the second embodiment illustrated in FIG. 12, body 112 may be solid and contain no opening or, as shown in the third embodiment illustrated in FIG. 18, body 212 may contain solid, transparent window 224 that allows for visualization of the IOL in bore 218. In addition, window 224 may contain outline 226 of an IOL that indicates correct orientation of the IOL in cartridge 210. In the embodiments illustrated in FIGS. 1, 4 and 12, proximal end 26 and 126 of bodies 12 and 112, respectively, may contain peg 28 and 128 around which haptic 22 may be wrapped, as illustrated in FIG. 10. Such an orientation of haptic 22 helps prevent haptic 22 from being caught by the mechanism driving IOL 20 down bore 18 or 118.

As best seen in FIGS. 5-17 and 19, bore 18, 118 and 218 is asymmetric in transverse cross-section, rounded on one side 30, 130 and 230 and ramped on the other side 32, 132 and 232 near proximal end 26, 126 and 226, tapering into an oval or circle near nozzle 14, 114 and 214. As best seen in FIGS. 6-11, ramped side 32 holds edge 33 of IOL 20 relatively flat as IOL 20 is pushed down bore 18 while rounded side 30 of bore 18 rolls or folds edge 31 of IOL 20. Gently rounding off ramped side 32 near nozzle 14 allows side 32 to roll or fold edge 33 after edge 31 has been rolled, as shown in FIGS. 6 and 7. Such an asymmetric construction slowly folds one side of IOL 20 at a time and is particularly advantageous when IOL 20 is made from a viscoelastic material such as a soft acrylic, because such gentle folding allows the material to flow into the folded shape with less potential for damage to IOL 20. In addition, the asymmetric folding action of the present invention helps prevent haptics 22 from becoming trapped or pinned within bore 18 by IOL 20 and being damaged.

Alternatively, as seen in FIGS. 21-31, bore 318 may be ramped on one side 332, but may contain flat ledge or shelf 334. Shelf 334 extends only partially down bore 318 and helps to ensure proper placement of IOL 20 during loading.

In order to facilitate further the movement of IOL 20 down bore 18, 118 and 218, interior surface 19, 119, 219 and 319 of bore 18, 118, 218 and 318 may be coated with a

lubricous coating such as those described in U.S. Patent Nos. 4,487,865, 4,500,676, 4,663,233, 4,801,475, 4,959,074, 5,023,114 and 5,037,677, the entire contents of which are incorporated herein by reference. Bore 18, 118, 218 and 318 may also be coated by any commercially available medical grade viscoelastic, such a VISCOAT® viscoelastic available from Alcon Laboratories, Inc., Fort Worth, Texas. The inventors have also found that texturizing interior surface 19, 119, 219 and 319 also assists in the movement of IOL 20 down bore 18, 118, 218 and 318 by minimizing the amount of surface contact between interior surface 19, 119, 219 or 319 and IOL 20 and by entrapping any viscoelastic agent between interior surface 19, 119, 219 or 319 and IOL 20. For example, a surface roughness of greater than 0.45 microns RMS may be used. Such a finish can be generated by a two step process incorporating an initial random pattern texture by sandblasting or acid etching followed by a specific directional polish along the longitudinal axis of bore 18, 118, 218 or 318 in order to achieve a cropped or plateau effect.

While certain embodiments of the present invention have been described above, these descriptions are given for purposes of illustration and explanation. Variations, changes, modifications, and departures from the systems and methods disclosed above may be adopted without departure from the scope or spirit of the present invention.

We claim:

1. An intraocular lens injector cartridge, comprising:

a) a body having a bore, the bore being asymmetric in transverse cross-section and having a ramp on one side and containing a shelf on the other side opposite the ramp; and

b) an injection nozzle integrally formed with the body, the nozzle having a bore that communicates with the bore in the body.

2. The cartridge of claim 1, wherein the asymmetric bore has a textured interior surface.

3. The cartridge of claim 1, wherein the body contains a window.

4. The cartridge of claim 3, wherein the window contains an orientation outline.

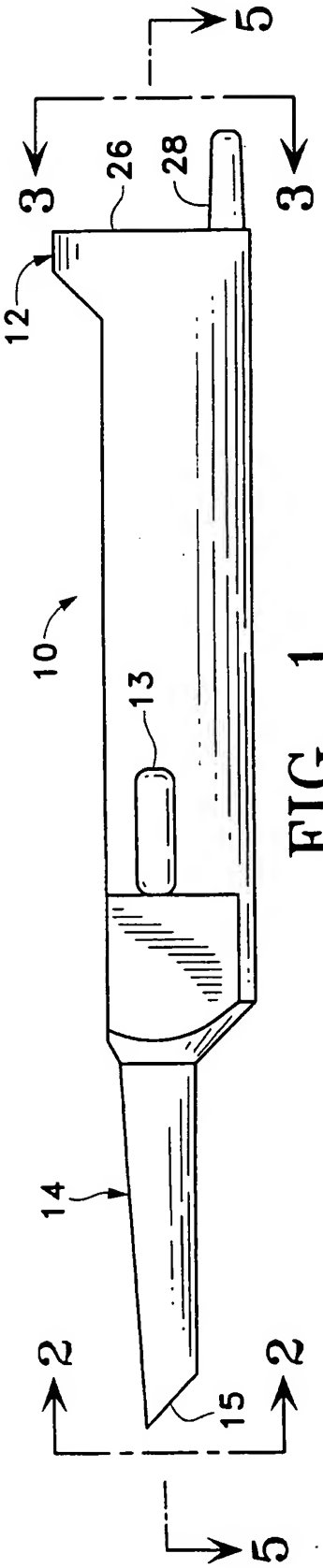

FIG. 1

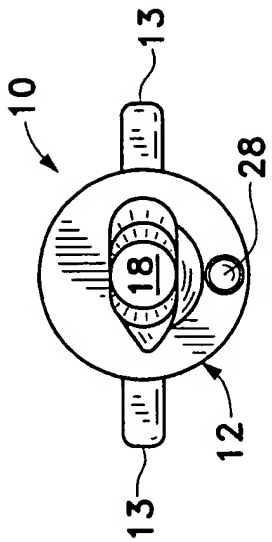

FIG. 3

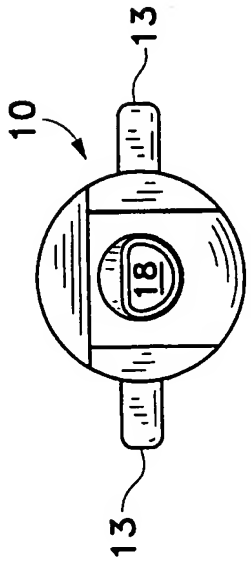

FIG. 2

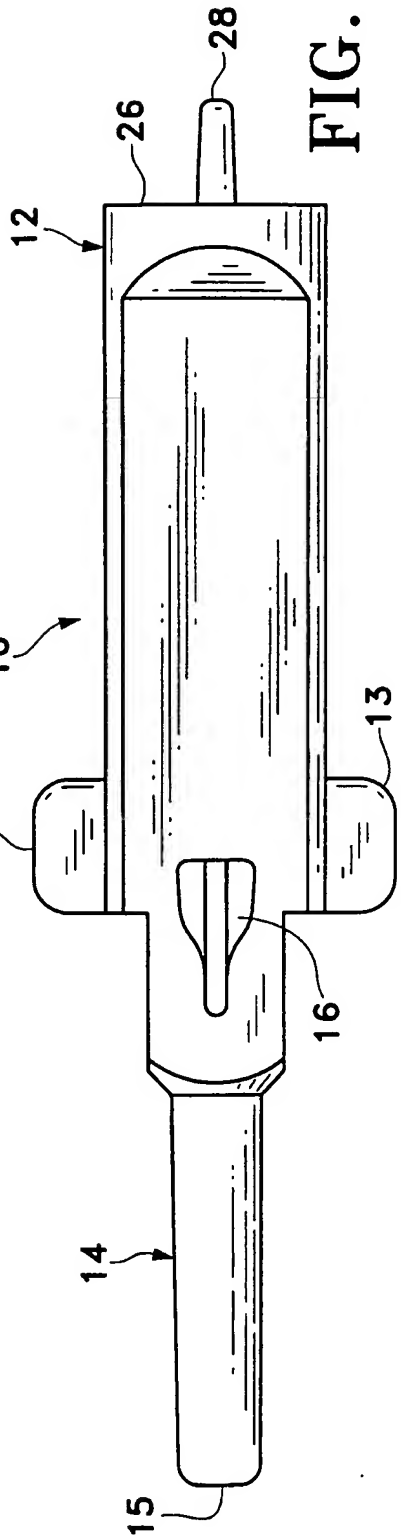

FIG. 4

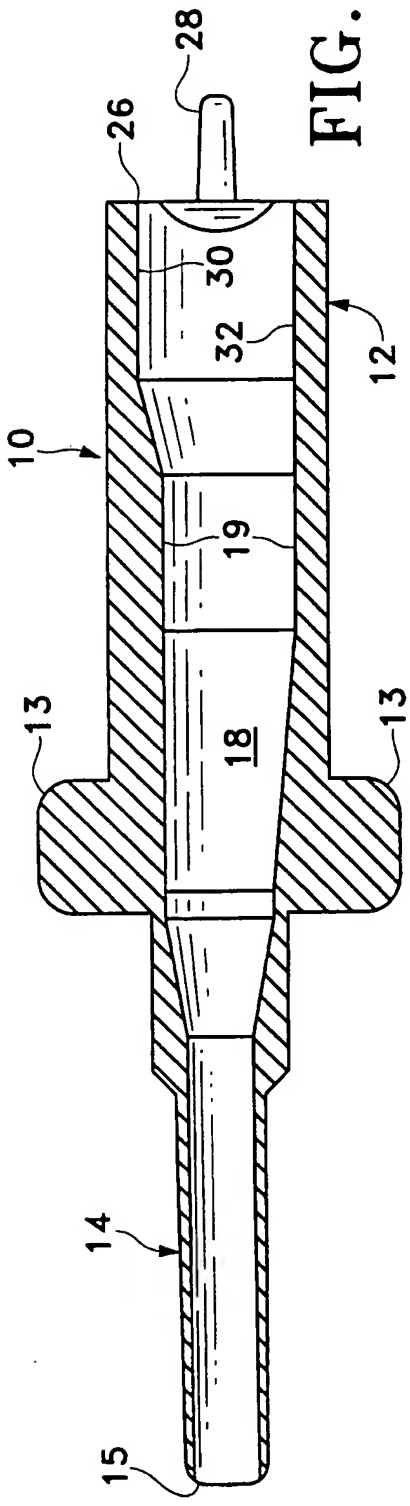

FIG. 5

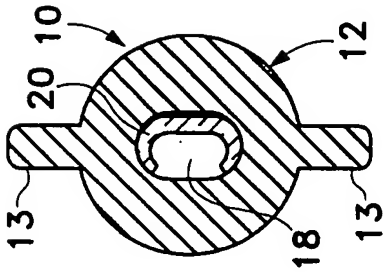

FIG. 7

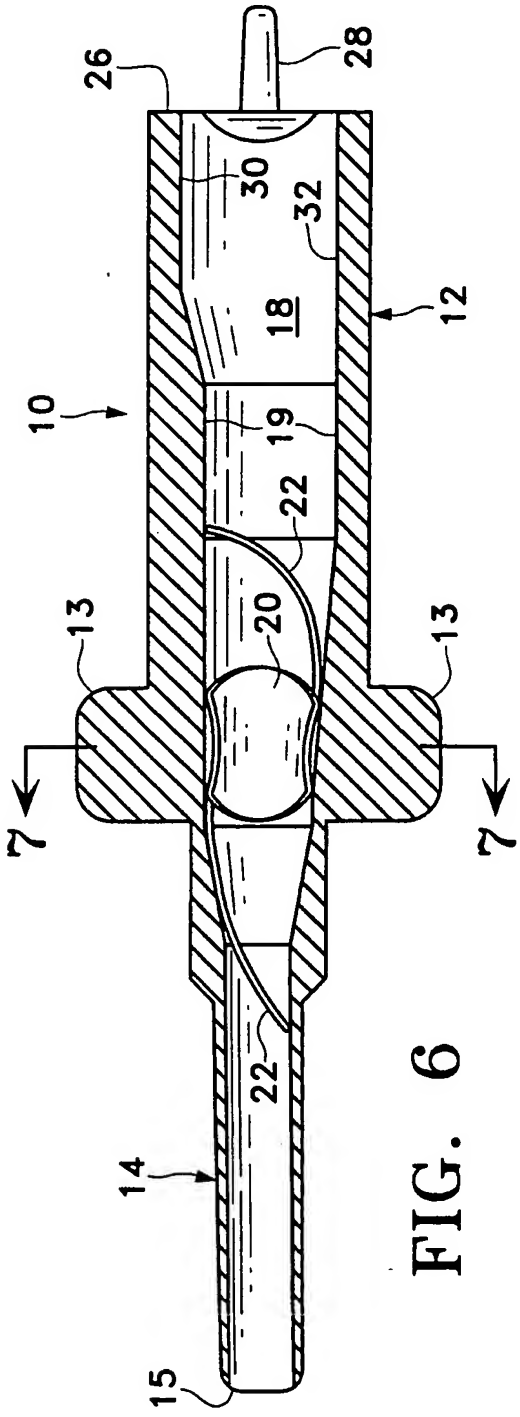

FIG. 6

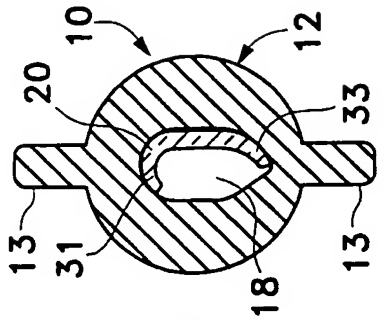

FIG. 9

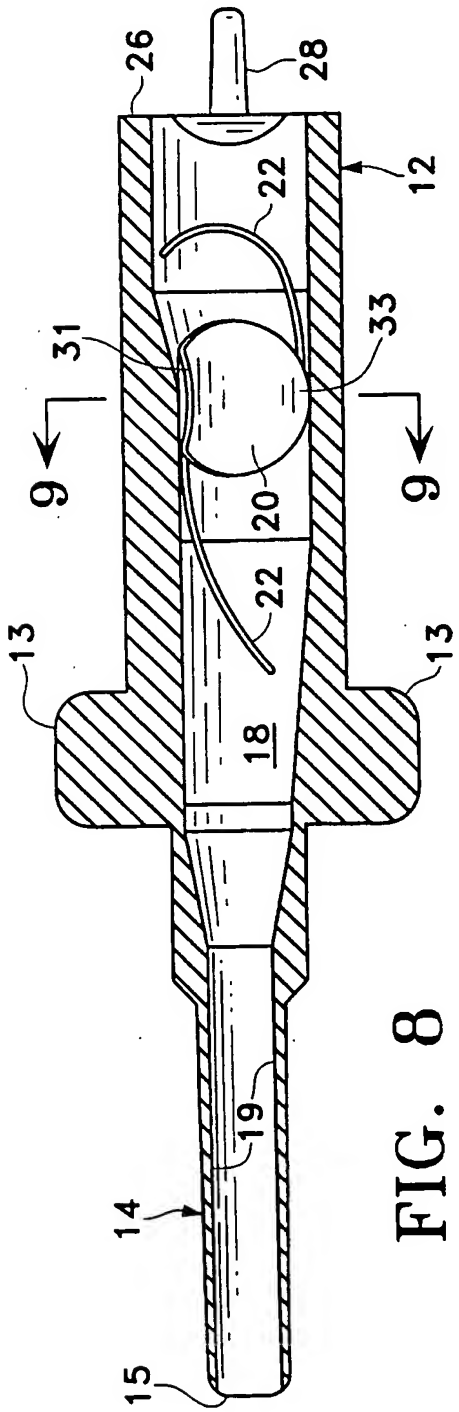

FIG. 8

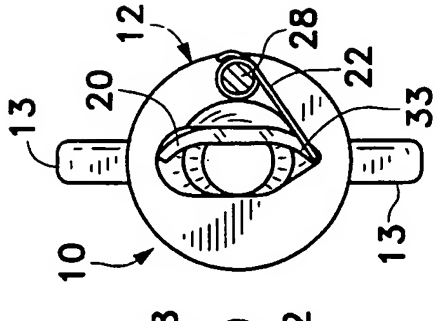

FIG. 11

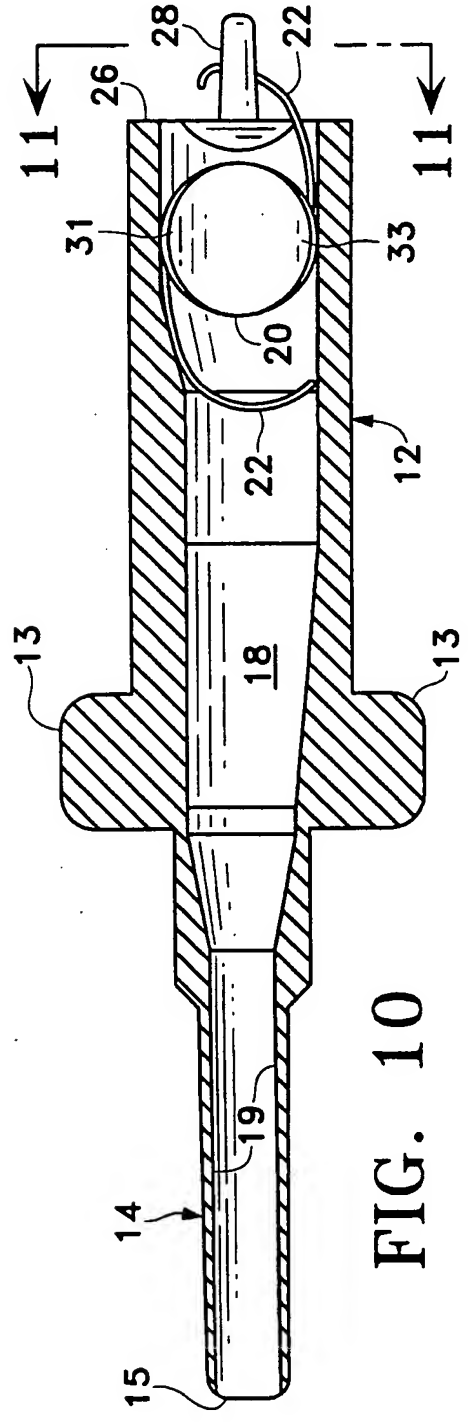

FIG. 10

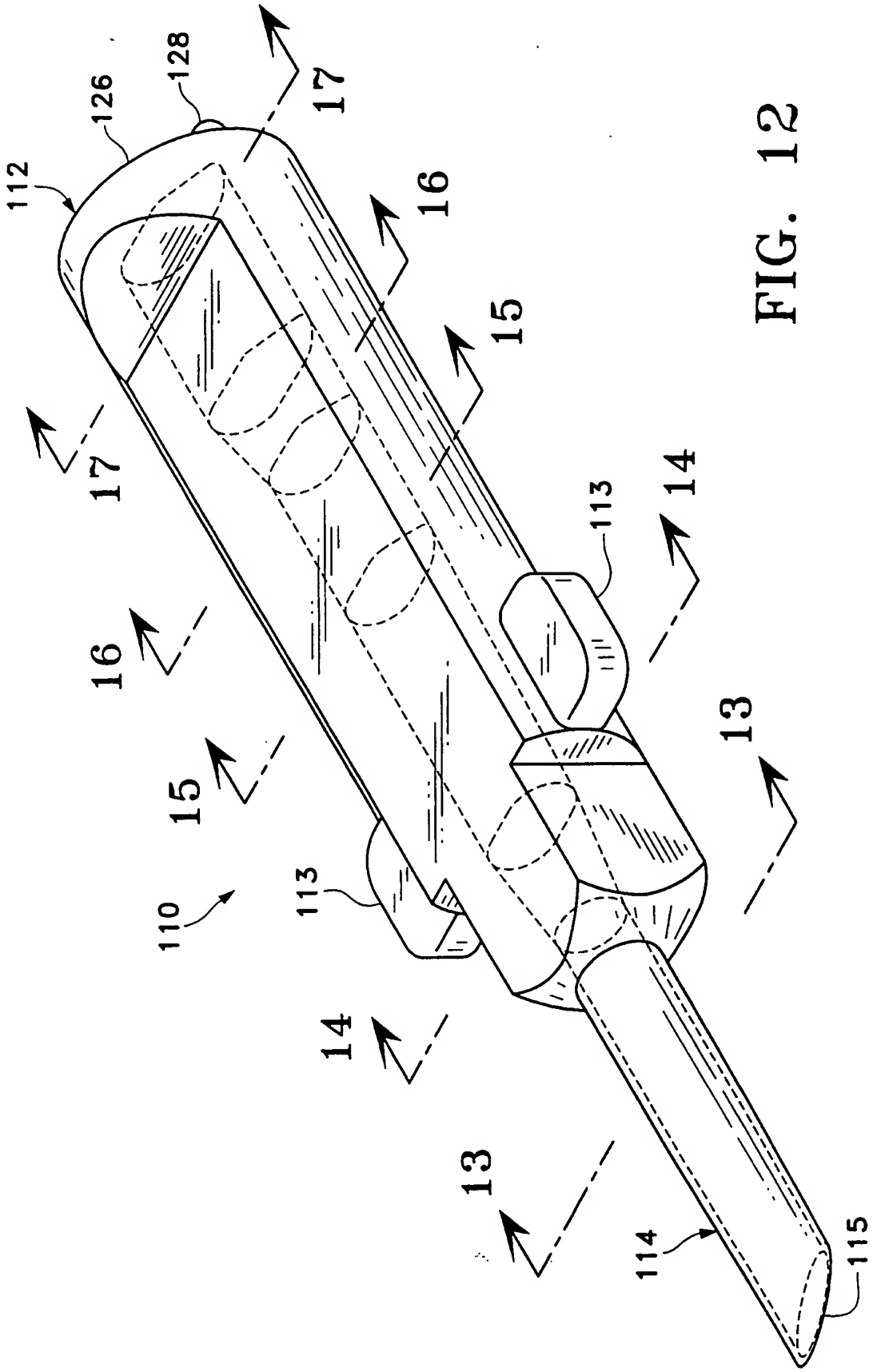

FIG. 12

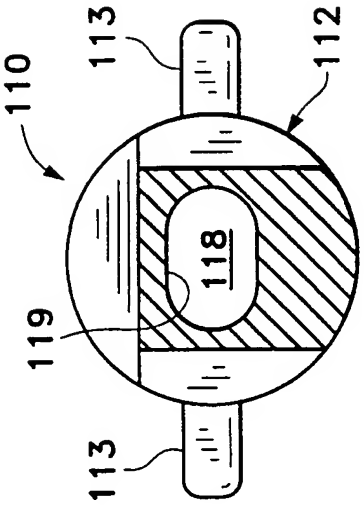

FIG. 14

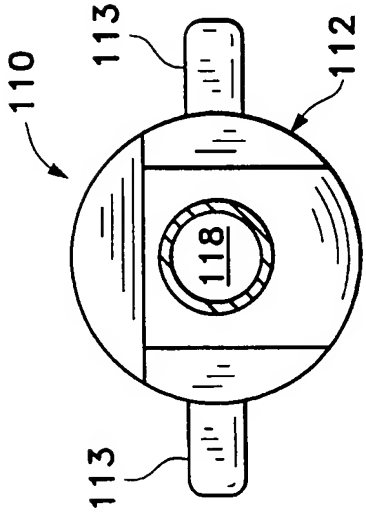

FIG. 13

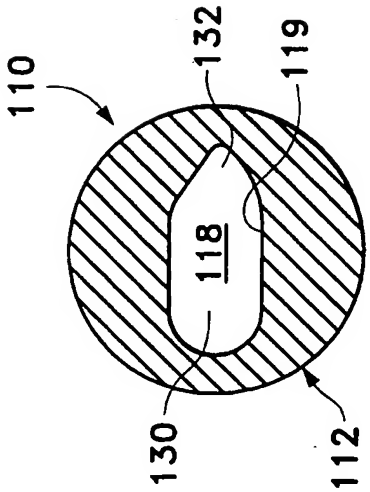

FIG. 17

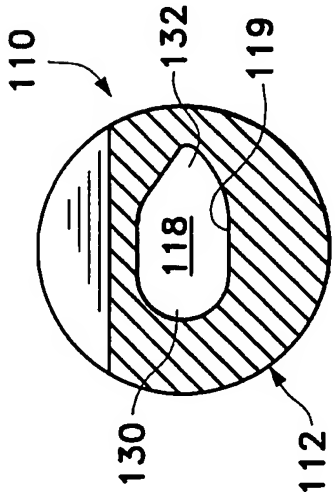

FIG. 16

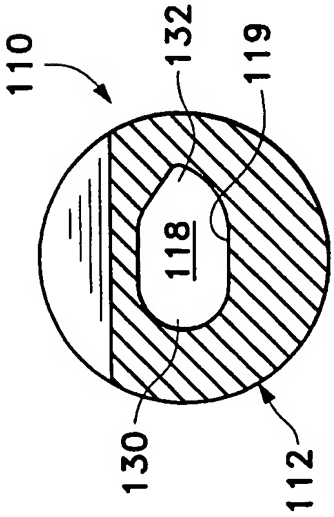

FIG. 15

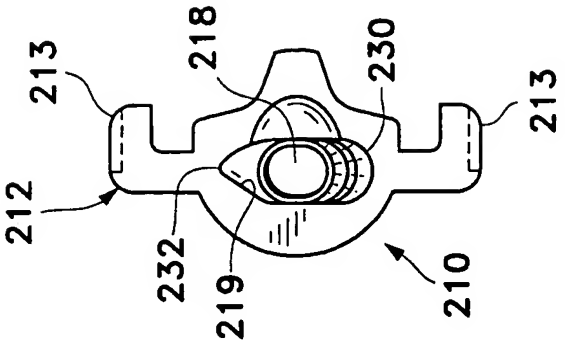

FIG. 19

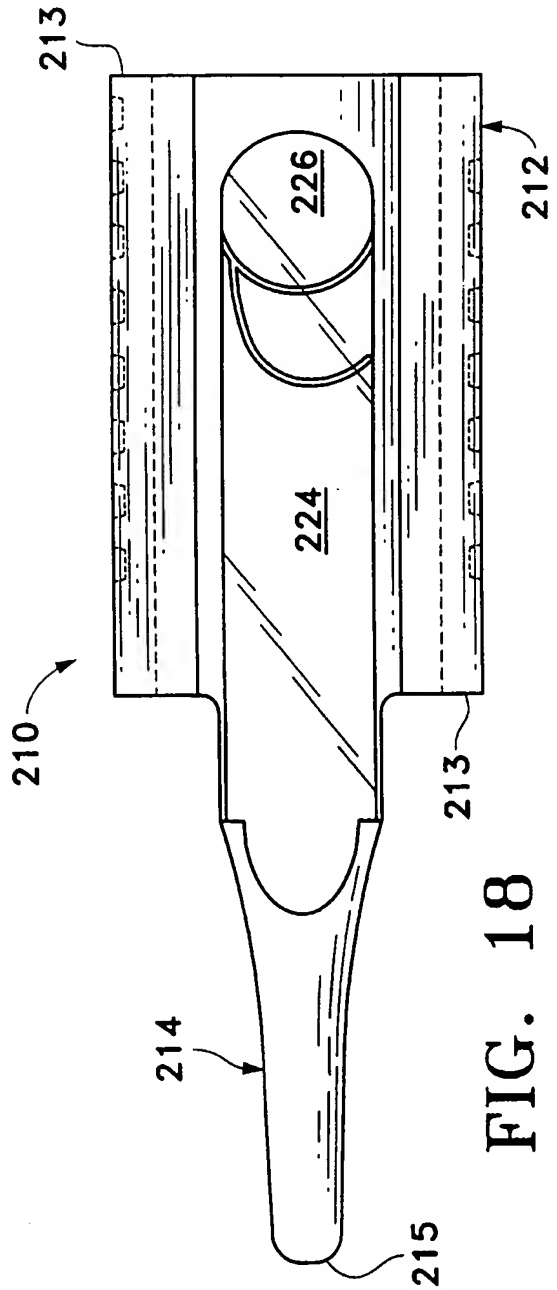

FIG. 18

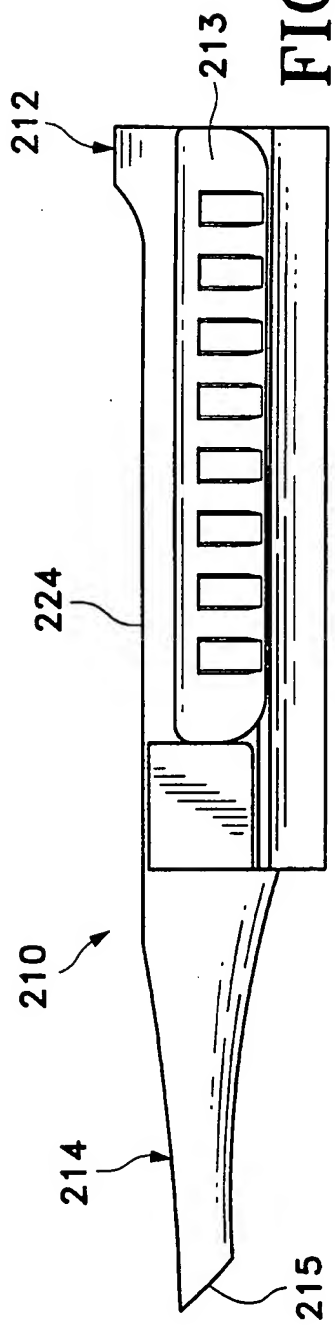

FIG. 20

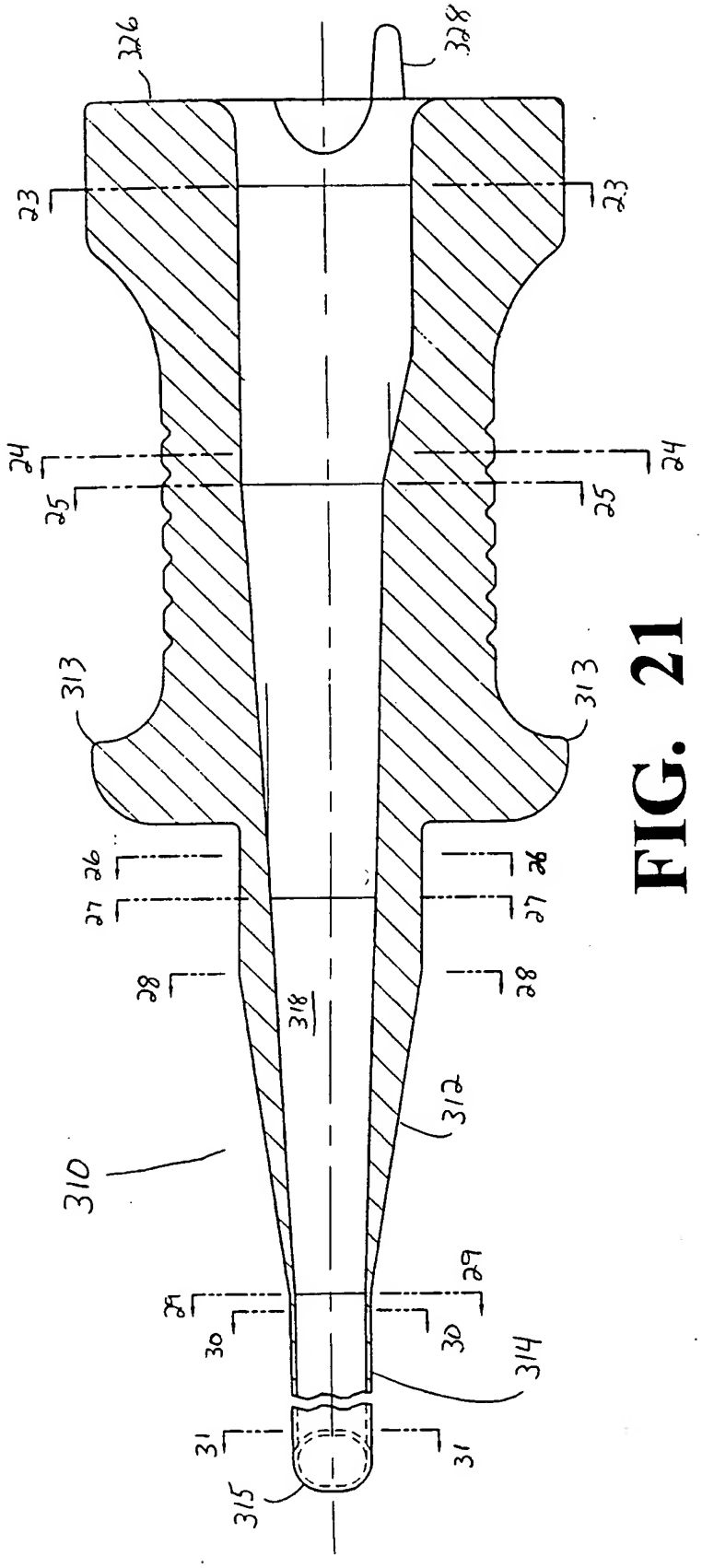
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FIG. 21

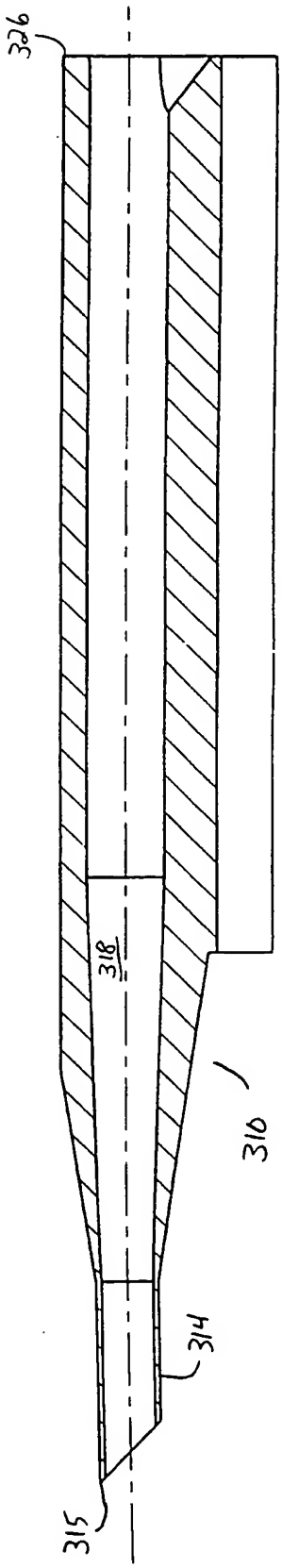
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FIG. 22

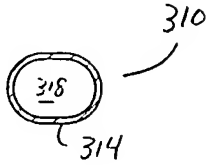

FIG. 31

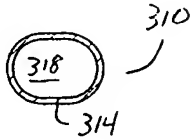

FIG. 30

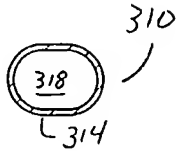

FIG. 29

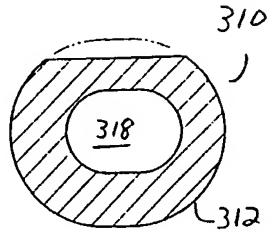

FIG. 28

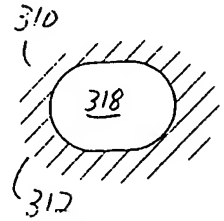

FIG. 27

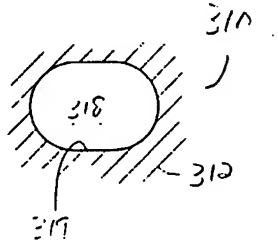

FIG. 26

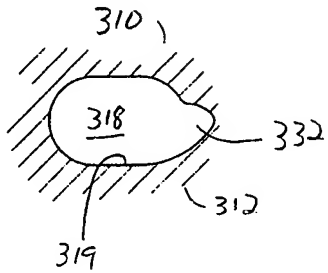

FIG. 25

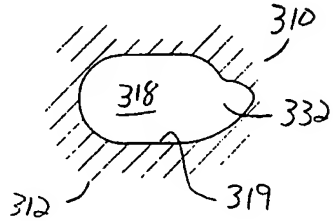

FIG. 24

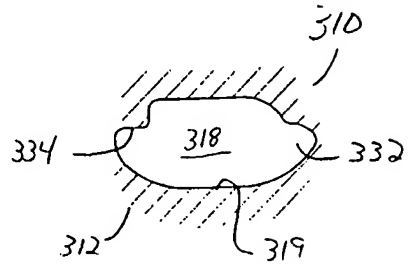

FIG. 23

INTERNATIONAL SEARCH REPORT

Inter. ɔnal Application No
PCT/US 00/07770

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61F2/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 12969 A (CHIRON VISION CORP) 2 April 1998 (1998-04-02) page 9, line 16 -page 10, line 12; figures ---	1
P,L, X	US 5 947 976 A (VAN NOY STEPHEN J ET AL) 7 September 1999 (1999-09-07) the whole document ---	1-4
A	WO 98 05281 A (STAAR SURGICAL CO INC) 12 February 1998 (1998-02-12) page 6, line 16 -page 7, line 4; figures 4-6 page 4, line 5 - line 12 ---	1-3
A	US 5 716 364 A (YANG SHIH-LIANG S ET AL) 10 February 1998 (1998-02-10) column 4, line 47 - line 67; figures --- -/--	1,2

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 July 2000	20/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Neumann, E

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INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 00/07770

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DE 43 01 573 A (OBERMAIER MARKO DR MED) 28 July 1994 (1994-07-28) claims 6,7; figures	1,3

2

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INTERNATIONAL SEARCH REPORT

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